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Energy Dispersive X-Ray Spectroscopy in Liquids: Inorganic and Biological Applications

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Combining energy dispersive X-ray spectroscopy (EDS) with liquid-cell scanning transmission microscopy (STEM) enables us to examine the structure and chemical composition of nanostructures in liquids. Liquid-phase spectrum imaging can be used to map elemental distribution and observe chemical changes in multi-metallic systems at the nanoscale.

Silicon-nitride windowed liquid-cells can be used for high resolution imaging of nanostructures in liquids, however EDS analysis is limited by the geometry of the cell set up. We have demonstrated the use of a modified liquid-cell which decreases X-ray shadowing, making nanometer resolution elemental mapping possible in liquids for the first time (Fig. 1) [1].

Studies of complex mixtures of inorganic nanostructures have demonstrated the technique's ability to simultaneously map multiple elements and observe process such as the growth of core-shell nanostructures, providing insights into the complex growth mechanisms associated with the formation and evolution of nanostructures in liquid [2]. Liquid cell EDS can also be applied to the study of hydrated biological specimens [3]. Bacterial reduction of metal salts is of interest as a low cost and environmentally benign synthetic route to nanomaterials. We have studied AuPd nanoparticle decorated bacterial cells synthesised by the co-reduction of Pd(II) and Au(III) by *Geobacter sulfurreducens* cells. Knowledge of the distribution of elements, on both the cellular and individual nanocrystal scale, could give considerable insights into both the mechanism of biological nanocrystal synthesis and the structure-property relationships in bio-nanoparticle catalysts. We combine in situ experiments on hydrated specimens in the liquid-cell with experiments in vacuum, demonstrating the complementary nature of these two approached [4].

References:

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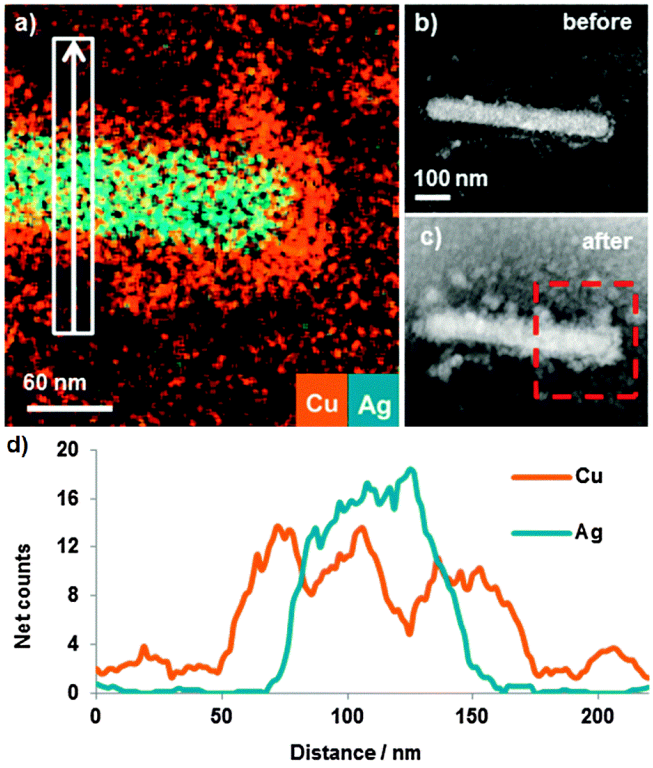

Figure 1. A bimetallic nanostructure in water was imaged before (b) and after (c) XEDS data acquisition, nanoparticle deposition has clearly occurred on and around the Ag-NW during data acquisition. Elemental map (a) extracted from the XEDS spectrum image, for the region of interest indicated by the dotted line in (c), shows an Ag-NW coated in Cu nanoparticles. An X-ray line profile (d) extracted from the spectrum image shows elevated Cu concentration on and around the Ag-NW [2], with permission from The Royal Society of Chemistry.

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